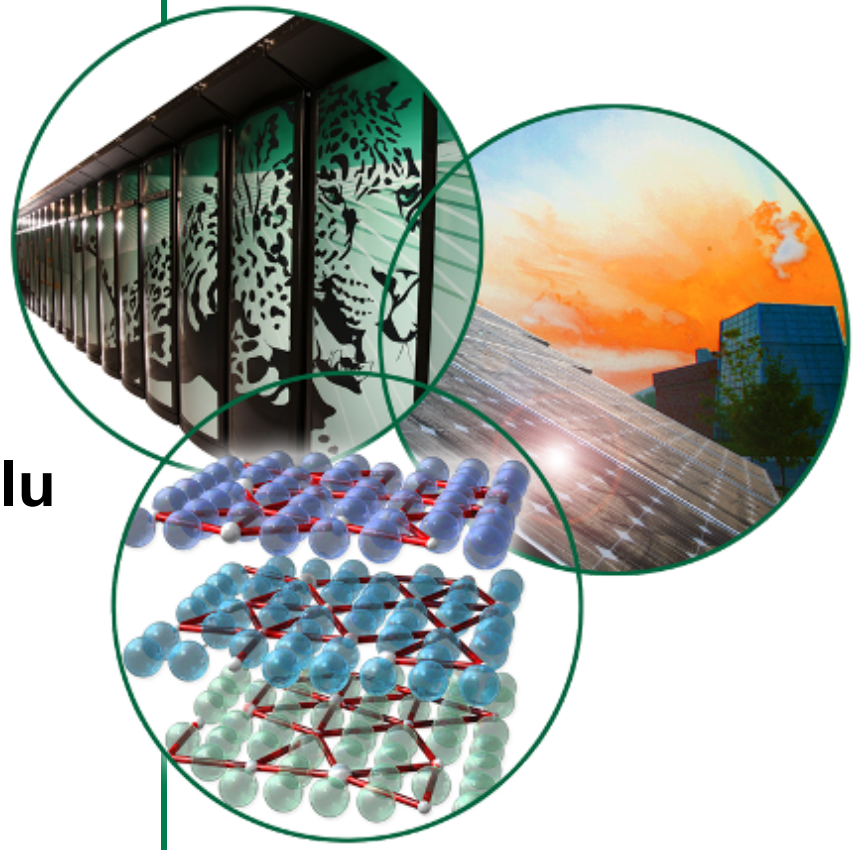
ORNL NCSP FY10 Overview and RSICC and AMPX Accomplishments



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Reactor and Nuclear Systems Division

US DOE Technical Seminar
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U.S. DEPARTMENT OF ENERGY

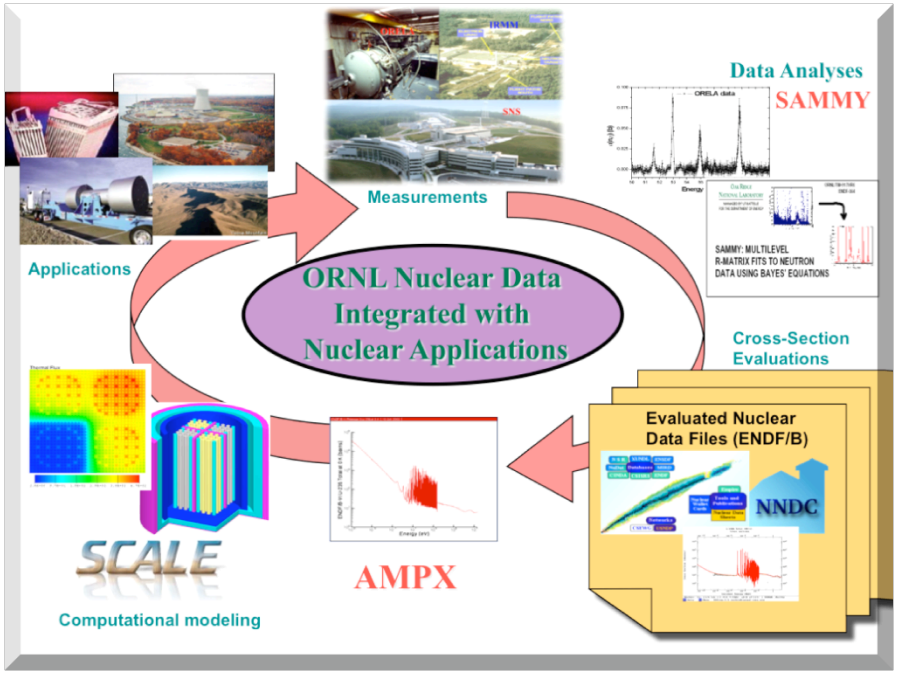
OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

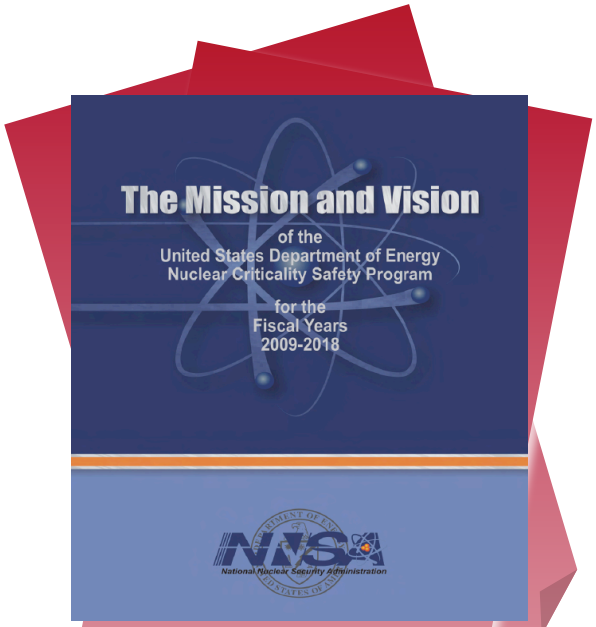
Outline

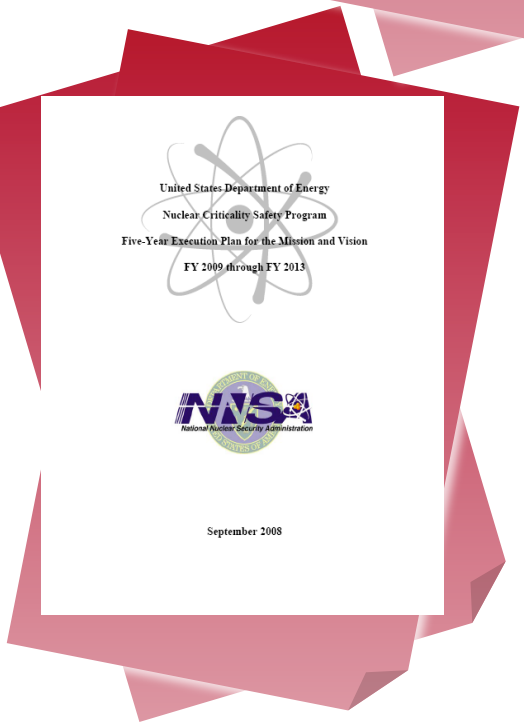
- ORNL NCSP FY10 Overview
- Radiation Safety Information Computational Center (RSICC)
- AMPX Cross-Section Processing System
- Summary

ORNL NCSP OVERVIEW

- ORNL provides technical support to NCSP in multiple technical areas:
  - RSICC—NCS nuclear software and data testing and distribution
  - Nuclear data measurements & evaluations
  - SAMMY and AMPX code development
  - SCALE NCS code development, maintenance
  - ICSBEP participation
  - Critical experiment design team (C_EDT)
  - CAAS shielding experiment benchmark design and execution
  - Training & Education Program Development



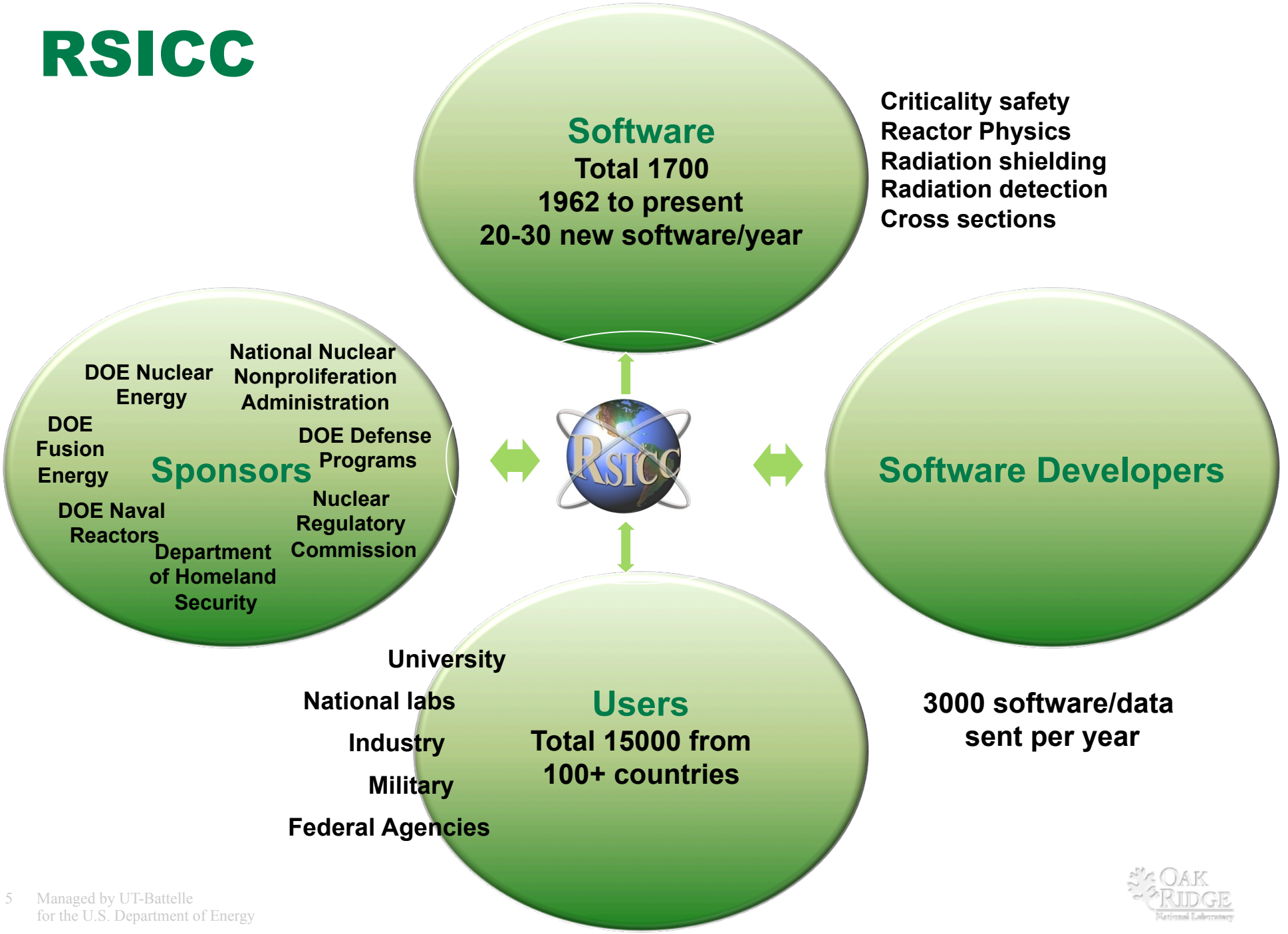




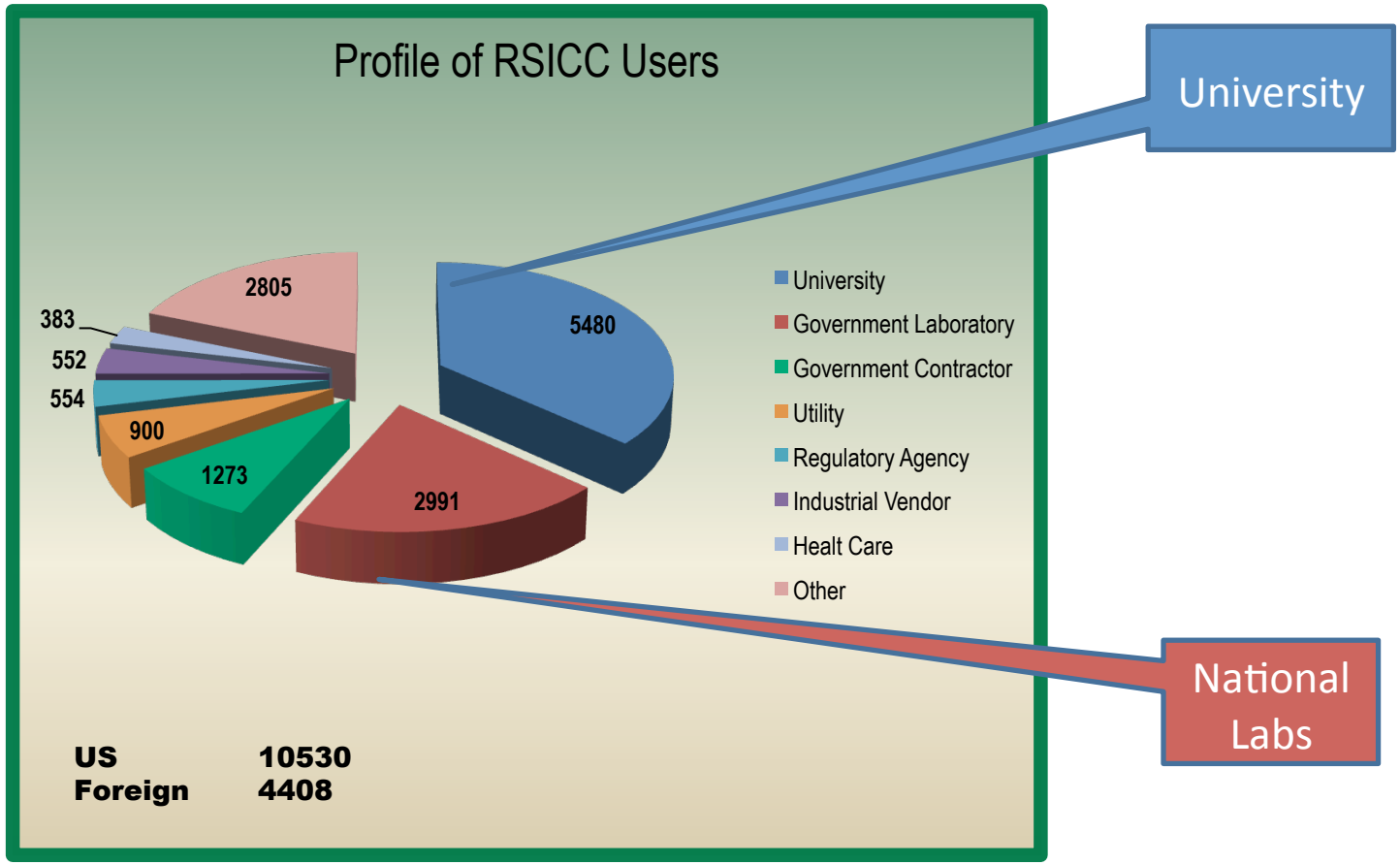
ORNL AM Subtask 1: RSICC NCSP Software Archival, Packaging, and Dissemination

- **Objective:** Support NCSP mission by maintaining and disseminating the essential technical software tools and processed data used by NCS specialists responsible for safe, efficient, fissionable material operations within the DOE Complex:
  - Collect, independently test, disseminate NCS tools such as SCALE, MCNP, VIM, and COG along with the nuclear data tools AMPX, NJOY, and SAMMY needed to support NCSP technical work tasks
  - Test and distribute processed nuclear data libraries need by the radiation transport software
  - Coordinates processing of software and data package requests to ensure compliance with U.S. Export Control laws
  - Maintains electronic notebooks to facilitate lesson-learned communication between users and developers
  - Software and data package exchange through international agreements (OECD/NEA, RIST, etc)
- **Vision:** Addresses NCSP AM Vision to "maintain and disseminate the analytical tools and data libraries in a manner that is responsive to the needs of those responsible for developing, implementing, and maintaining criticality safety"
- **NCS Relevance:**
  - NCSP covers costs associated with code and data distribution—provide latest and most up-to-date software for NCS users
  - Communication and collaboration with international data centers facilitates technical exchanges with international community—provides valuable feedback loop to improve software for NCS

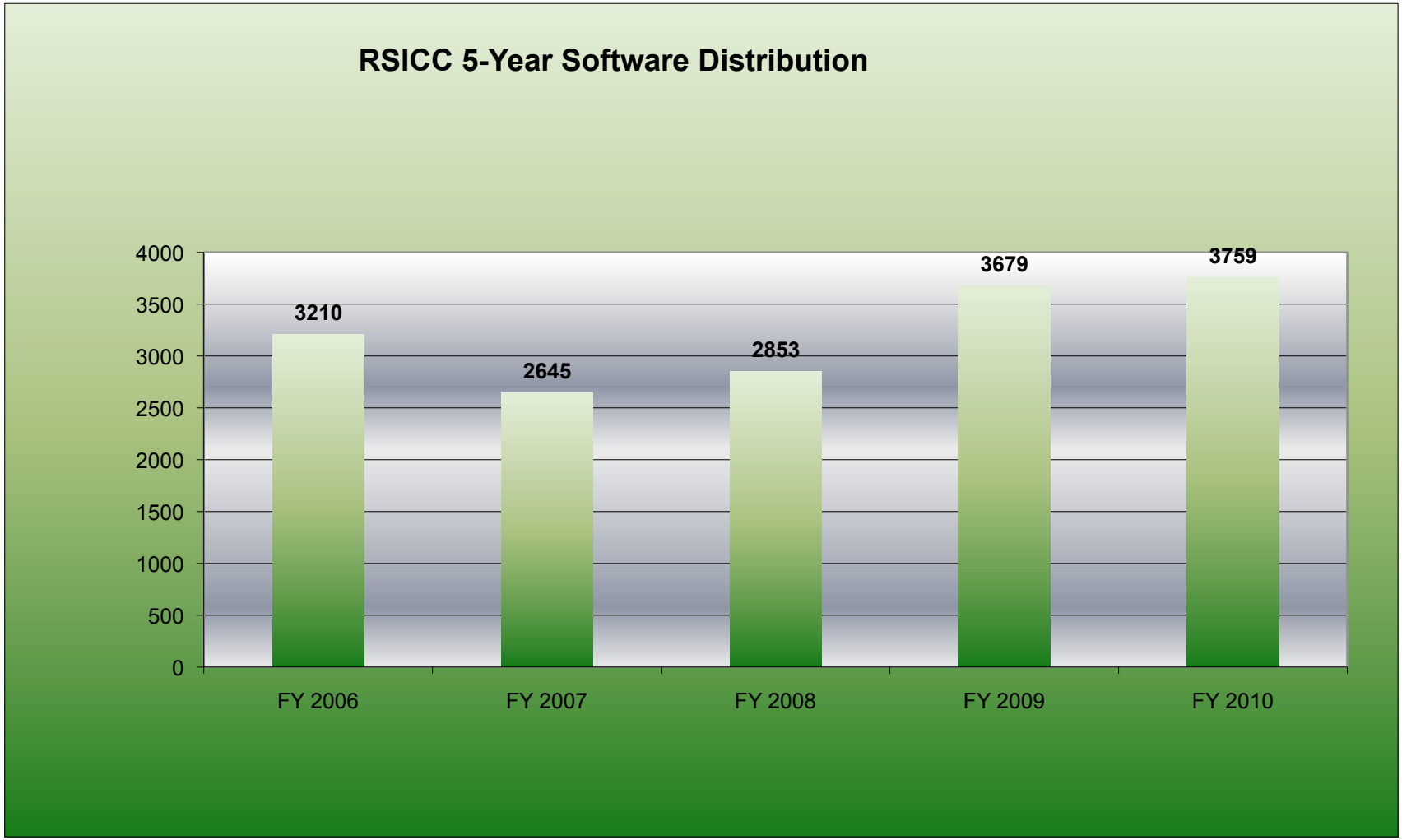
RSICC


Software
Total 1700
1962 to present
20-30 new software/year
Criticality safety
Reactor Physics
Radiation shielding
Radiation detection
Cross sections
Sponsors
DOE Nuclear Energy
National Nuclear Nonproliferation Administration
DOE Fusion Energy
DOE Defense Programs
DOE Naval Reactors
Nuclear Regulatory Commission
Department of Homeland Security
RSICC
Software Developers
3000 software/data sent per year
Users
Total 15000 from 100+ countries
University
National labs
Industry
Military
Federal Agencies

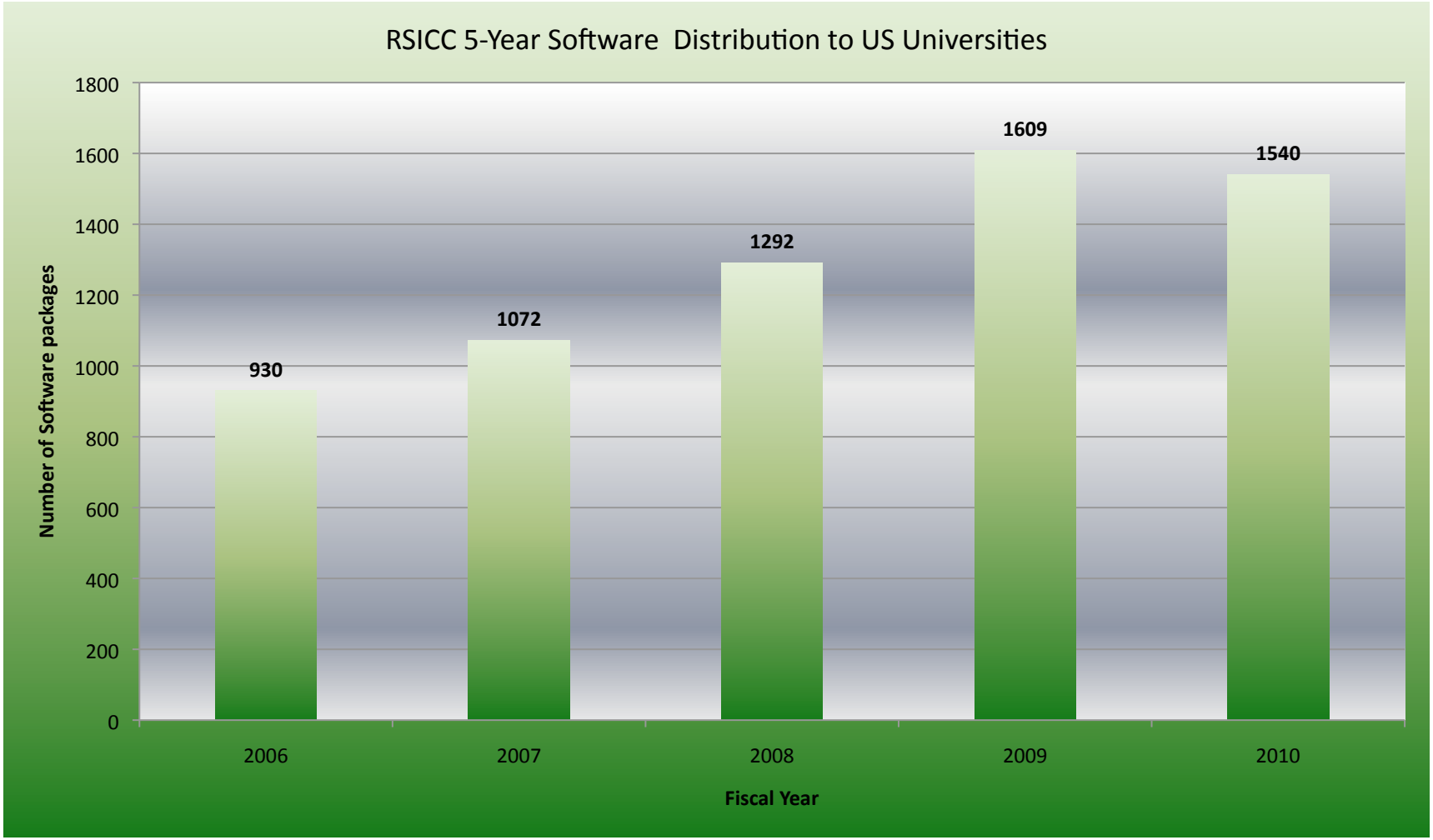
RSICC User Profile



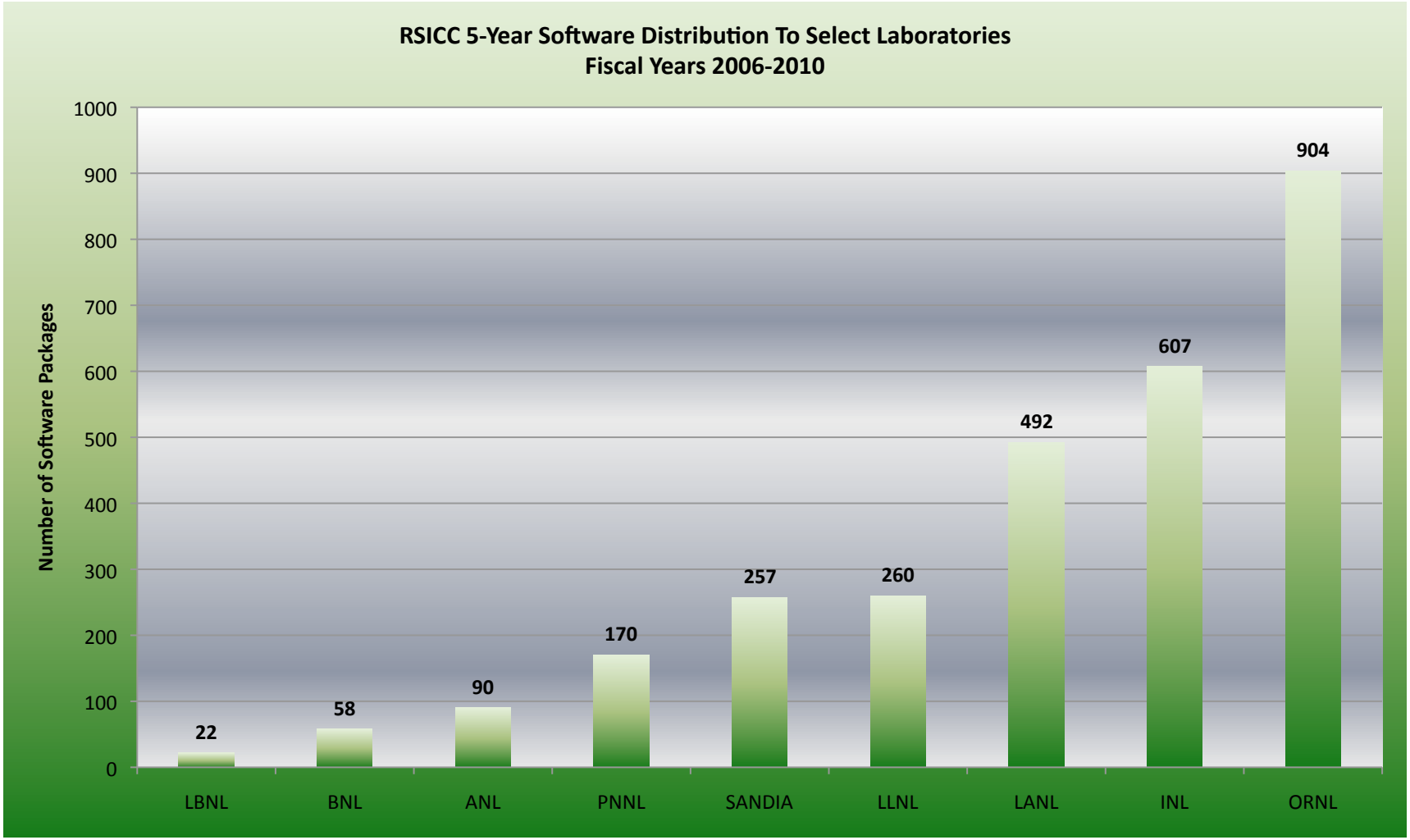
RSICC 5-Year Software Distribution



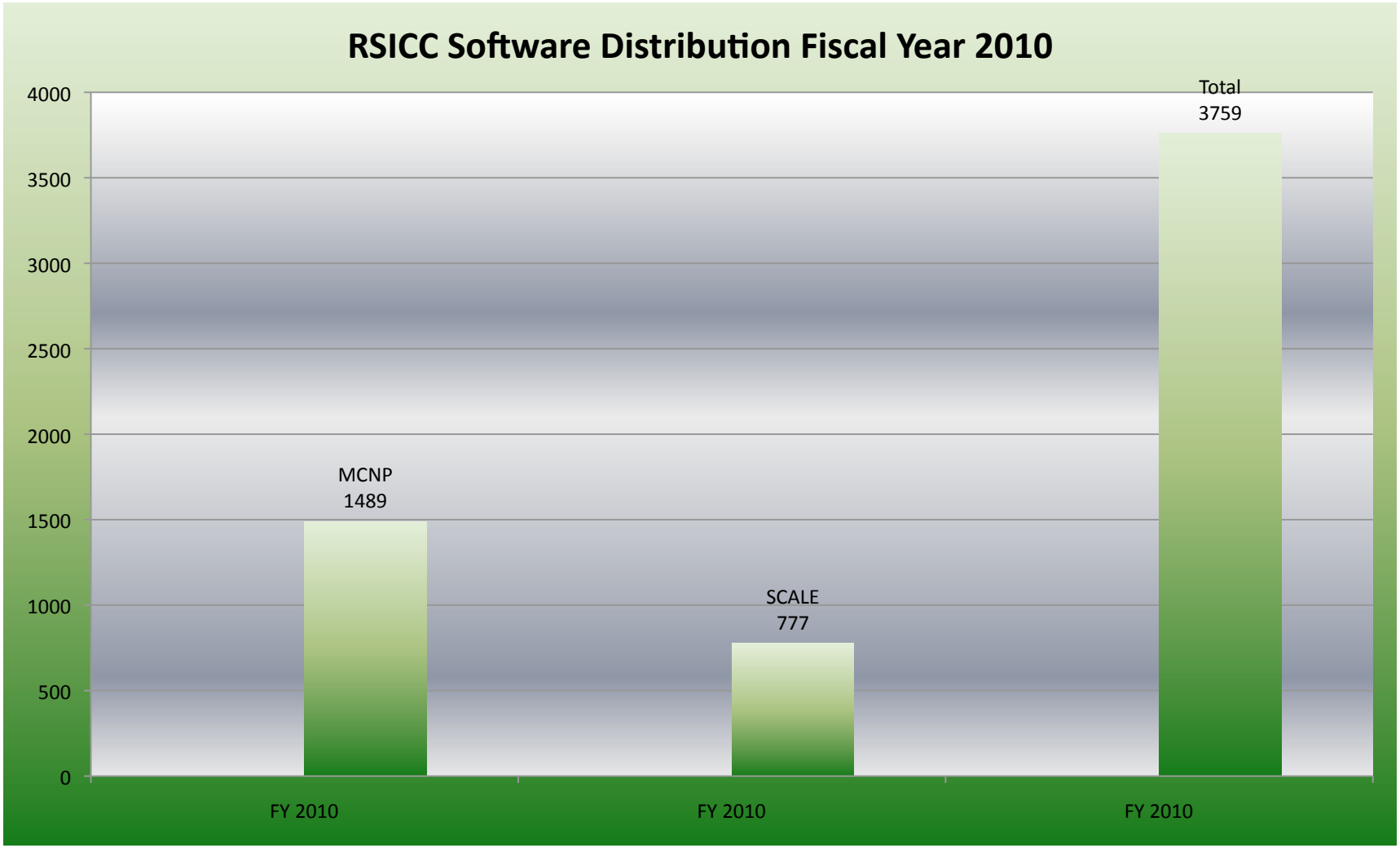
RSICC 5-Year Distribution to US Universities



RSICC 5-Year Distribution to Select National Laboratories



RSICC Software Distribution FY 2010 MCNP and SCALE

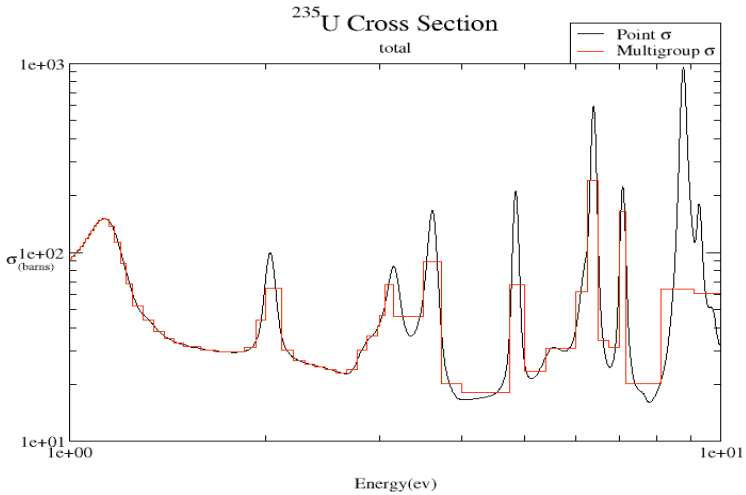


ORNL AM Subtask 4: AMPX Development & Maintenance

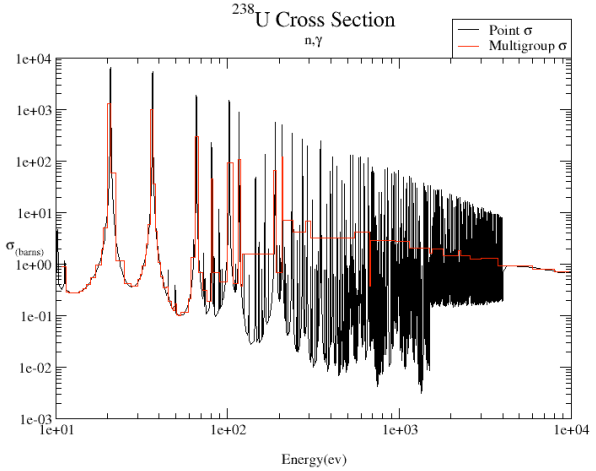
- **Objective:** Ensure AMPX cross-section processing system is available to provide nuclear data libraries for SCALE and other transport packages to support NCS analyses:
  - Keep processing software current and up-to-date with Evaluated Nuclear Data File (ENDF/B) formats and procedures
  - Process evaluated cross-section data provided through new measurement and evaluation work efforts under the NCSP Nuclear Data Program Element
  - Provide AMPX user support and SCALE nuclear data library support
  - Software enhancements to facilitate improved processing capabilities in addition to providing new reaction physics capabilities to support radiation transport methods development
- **Vision:** Addresses AM strategy for NCSP Mission & Vision Plan to "provide and support data processing codes and tools containing rigorous physics models to produce data libraries required by the transport codes from cross-section evaluations."
- **NCS Relevance:**
  - Maintains the SCALE radiation transport data libraries used for NCS analyses
  - Assures the latest cross-section evaluations can be processed to provide the NCS software with the latest evaluated nuclear data

AMPX Cross-Section Processing System

- SCALE relies on AMPX for data libraries
  - **MG and CE cross-section data**
  - **Data processing procedures including problem-dependent resonance self-shielding**
  - **Cross-section uncertainty data to support S/U methods in SCALE**



- AMPX Processes ENDF/B Formats
  - **Generate Temperature-Dependent Pointwise Cross Sections**
  - **Provide Resonance Self-Shielding for RRR and URR**
  - **Probability Table Generation for URR**
  - **Energy and Angle Distributions for Secondary Particles**
  - **Process S(α,β) Data for Thermal Moderators**
  - **Generate free-gas S(α,β) Data for Non-Thermal Moderators**
  - **Process Particle-Yield Data**
  - **Generate Pointwise Weighting Spectra**
  - **Multigroup Averaging Operations**
  - **Process Cross-Section Uncertainty Data for TSUNAMI**
  - **Automated Library Production—Process Multiple Nuclides**

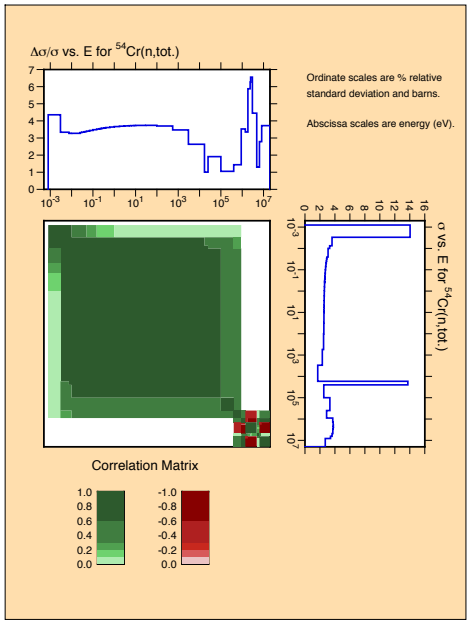


AMPX Cross Section Data for SCALE

- Multigroup (MG) Libraries
  - AMPX Master Library (general)
    - Very general, include temperature-dependent cross-section data and resonance data
    - Distributed with SCALE
    - Used as a basis for creating an AMPX working format library that is problem-dependent
  - Working Library (e.g., Used by XSDRNPM and KENO)
    - Problem-dependent data generated by processing master library with BONAMI and NITAWL or CENTRM/PMC
- Covariance libraries (COVERX format)—PUFF-IV Module
- Continuous Energy (CE) Libraries
  - CENTRM
    - CE deterministic library distributed with SCALE
    - Used by CENTRM/PMC to self-shield multigroup data
  - CE-KENO
    - CE Monte Carlo library processed from same ENDF/B evaluations as ENDF/B-VI multigroup and CENTRM libraries

SCALE Data Libraries:

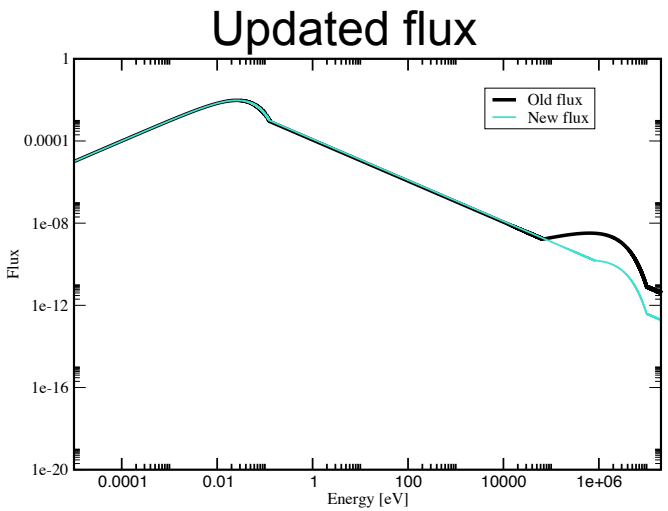
- CE ENDF/B-VI.8 and ENDF/B-VII.0
- 238-group ENDF/B-VI.8 and B-VII.0
- 200n47g ENDF/B-VI.8 and B-VII.0
- 27n19g ENDF/B-VII.0
- Recommended covariance data library
  - Evaluated and approximate covariance data
  - Covariance data for all ENDF/B nuclides (neutron)



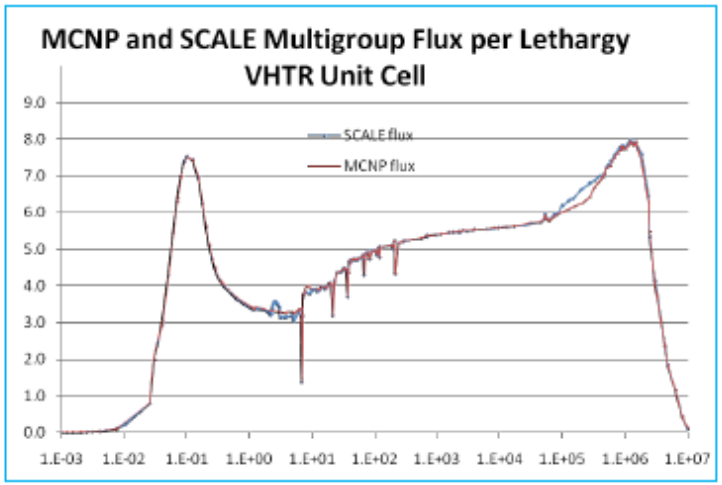
FY10 AMPX Accomplishment Highlights

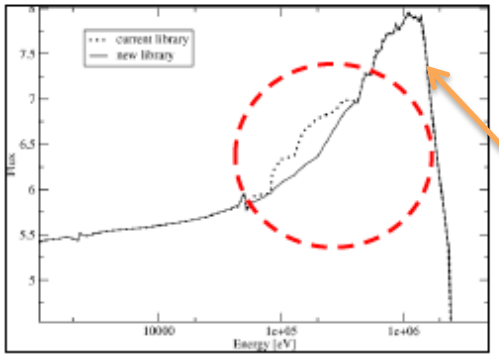
- Key work tasks
  - Update software and provide technical support for SCALE CE, MG, and covariance libraries
  - Complete automated sequences for AMPX to produce CE and MG SCALE data libraries
  - Process new ORNL cross-section evaluations to demonstrate evaluation conformance to ENDF/B formats/procedures
  - Chair OECD/NEA Working Party on Evaluation Cooperation (WPEC) on cross-section covariance processing—AMPX and NJOY are key covariance data processing tools
  - 'Stretch' goal (internal at ORNL): provide AMPX package to RSICC by end of FY10
- AMPX Software Updates
  - All modules have been converted to double-precision
  - Collision kinematics processing module improvements—treatment of gamma production matrices has been improved for ENDF/B coupled energy-angle (File 6) processing; ENDF/B File 12, 13, 14 and 15 treatment has been updated to use endflib.
  - Templates for multi-group and continuous energy library creation have been finalized—automated procedure to generate CE and MG libraries
  - **AMPX code package provided to RSICC at end of FY10 with draft user documentation—1 year ahead of schedule**
- Additional highlights on following slides

Updated criticality libraries for SCALE



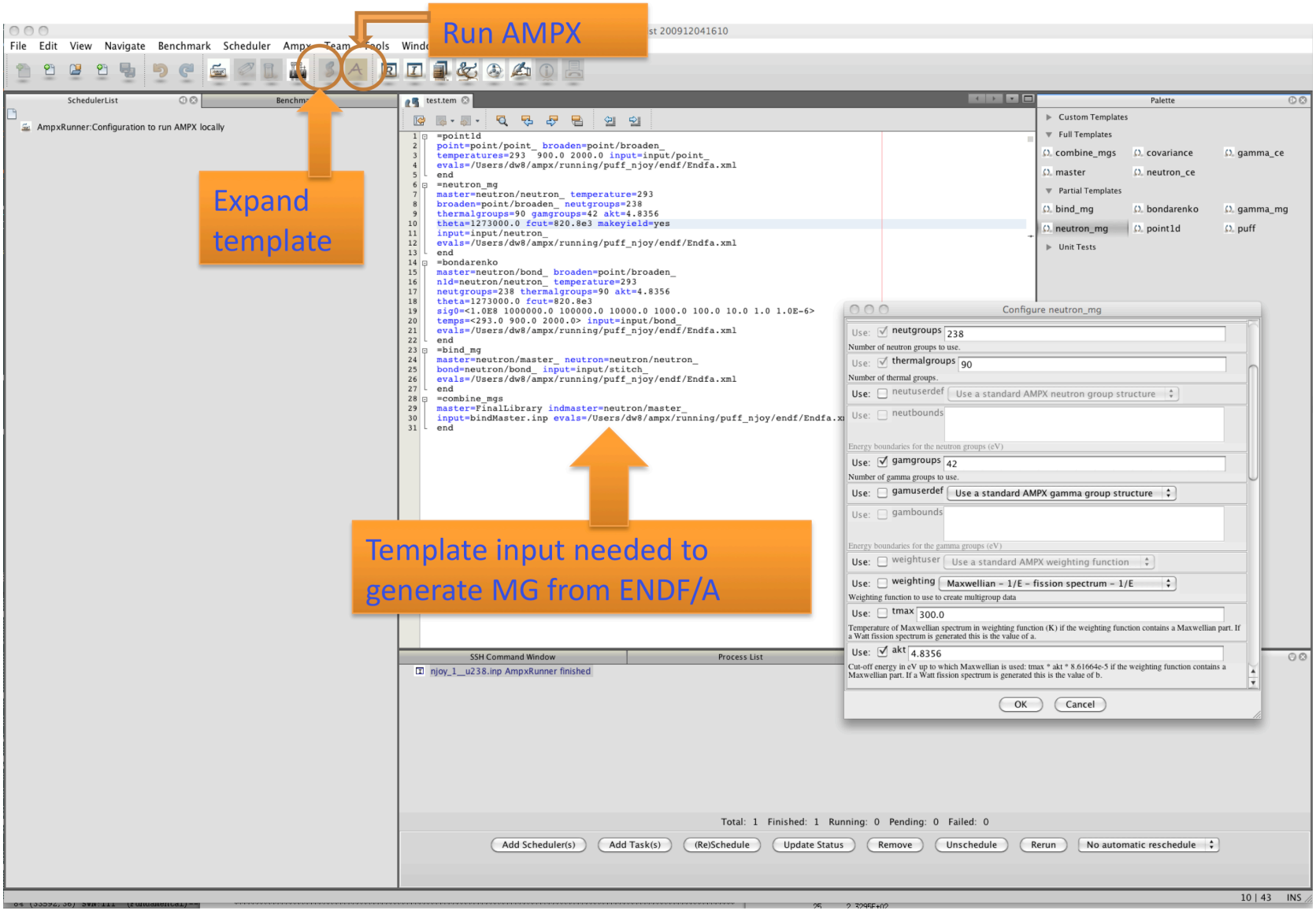
- New flux similar to VITAMIN-B7 spectrum used to create updated MG libraries:
- ENDF/B-VI.8 and ENDF/B-VII.0 libraries updated
- New double precision AMPX software used to generate new libraries
- Improved results for spectral calculations
- Benchmark k_{eff} values not affected





Improved flux with updated library

AMPX Graphical User Interface—updated to automate CE and MG Library Generation



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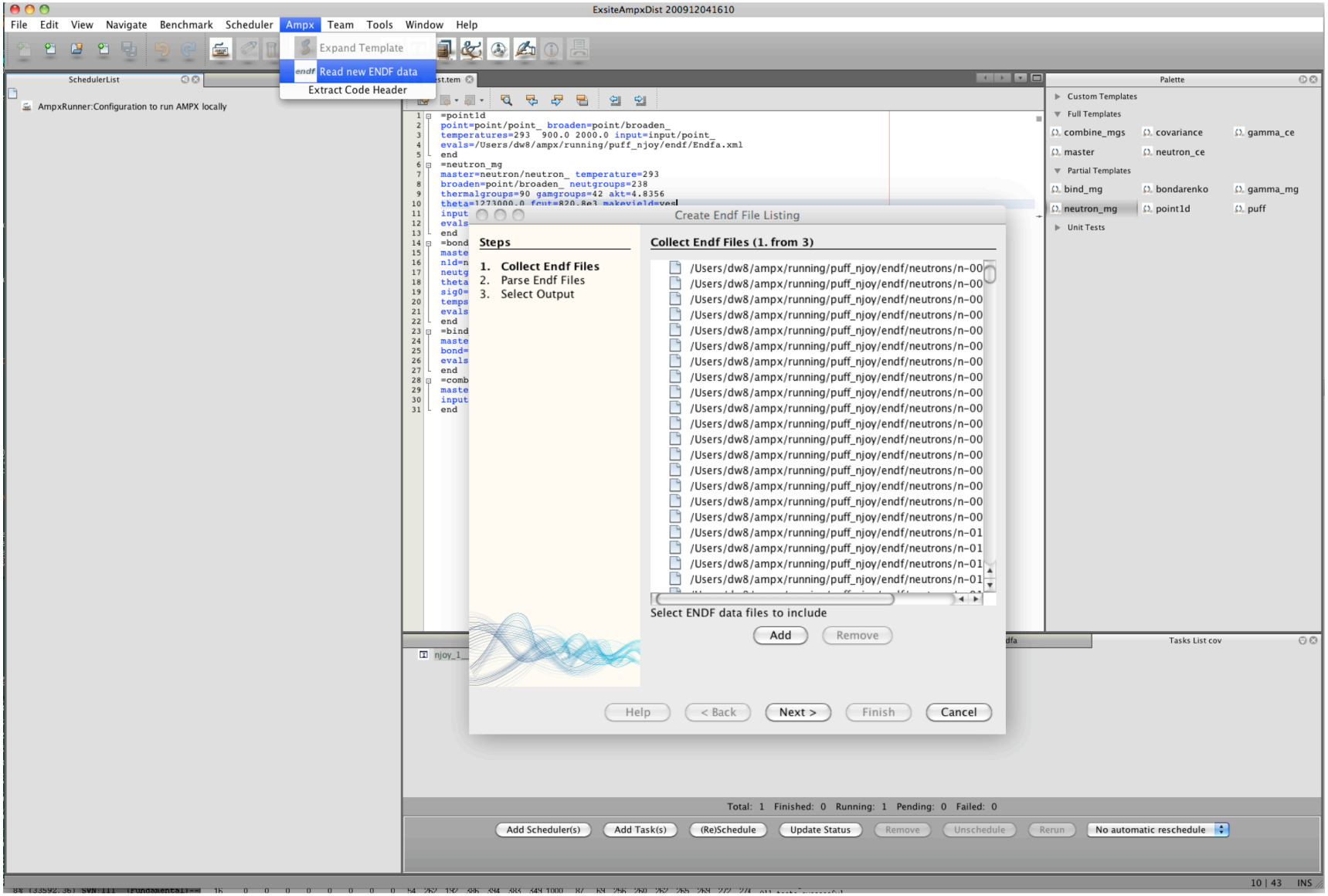
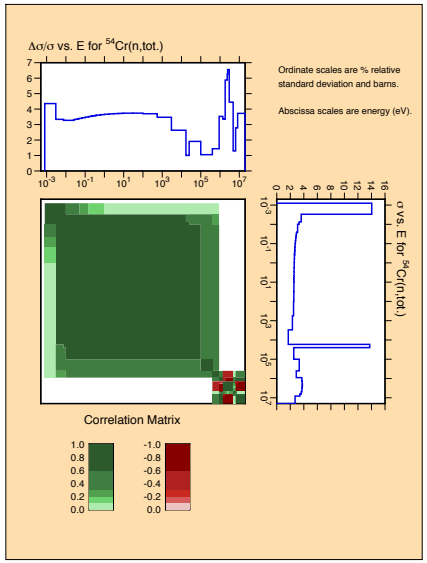
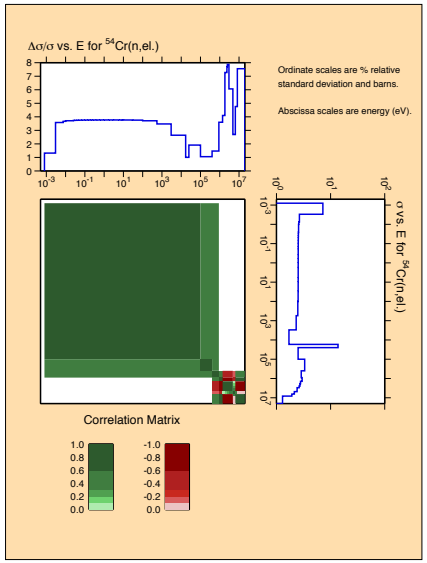
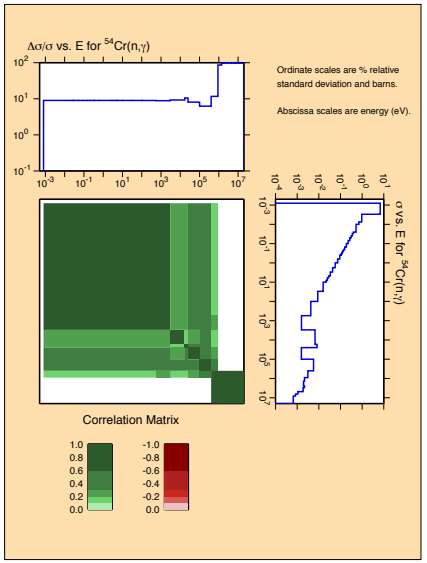


AMPX Processing of New ORNL Cross-Section Evaluations for submittal to NNDC

- ^{50,52,53,54}Cr—Four new evaluations with covariance data from ORNL (resonance region) and FZK (high-energy region)
- ^{48}Ti—new evaluation with covariance data from ORNL (resonance region) and LANL (high-energy region)
- ^{46,47,49,50}Ti covariance evaluation (ORNL) with new LANL high-energy evaluation
- Updated evaluations for ^{55}Mn and ^{233}U for ENDF/B-VII.1
- OECD/NEA WPEC subgroup activity: Processed all 'candidate' covariance evaluations for ENDF/B-VII.1 and compared with NJOY—demonstrate consistent results obtained with same processing options







Summary

- ORNL provides technical support to NCSP in multiple technical areas—subsequent talks with more details in Analytical Methods, Nuclear Data, Integral Experiments, and Training & Education
- RSICC NCSP software archival packaging, testing, and dissemination—distributed >2000 code packages (MCNP and SCALE) in FY10
- RSICC provided monthly newsletters announcing software updates, conferences, and workshops
- AMPX
  - Updated software to improve computational capabilities—generated new cross-section data libraries for release with SCALE 6.1
  - Provided technical support to SCALE users—investigate data issues and provide responses
  - Completed GUI development to automate cross-section data library generation and testing with AMPX
  - Provided AMPX package to RSICC
  - Processed new ORNL cross-section evaluations for submittal to NNDC for distribution as future ENDF/B evaluation release